The Spitzer Space Telescope: The First Year

Michael Werner – JPL

TPF/Darwin Conference – July, 2004

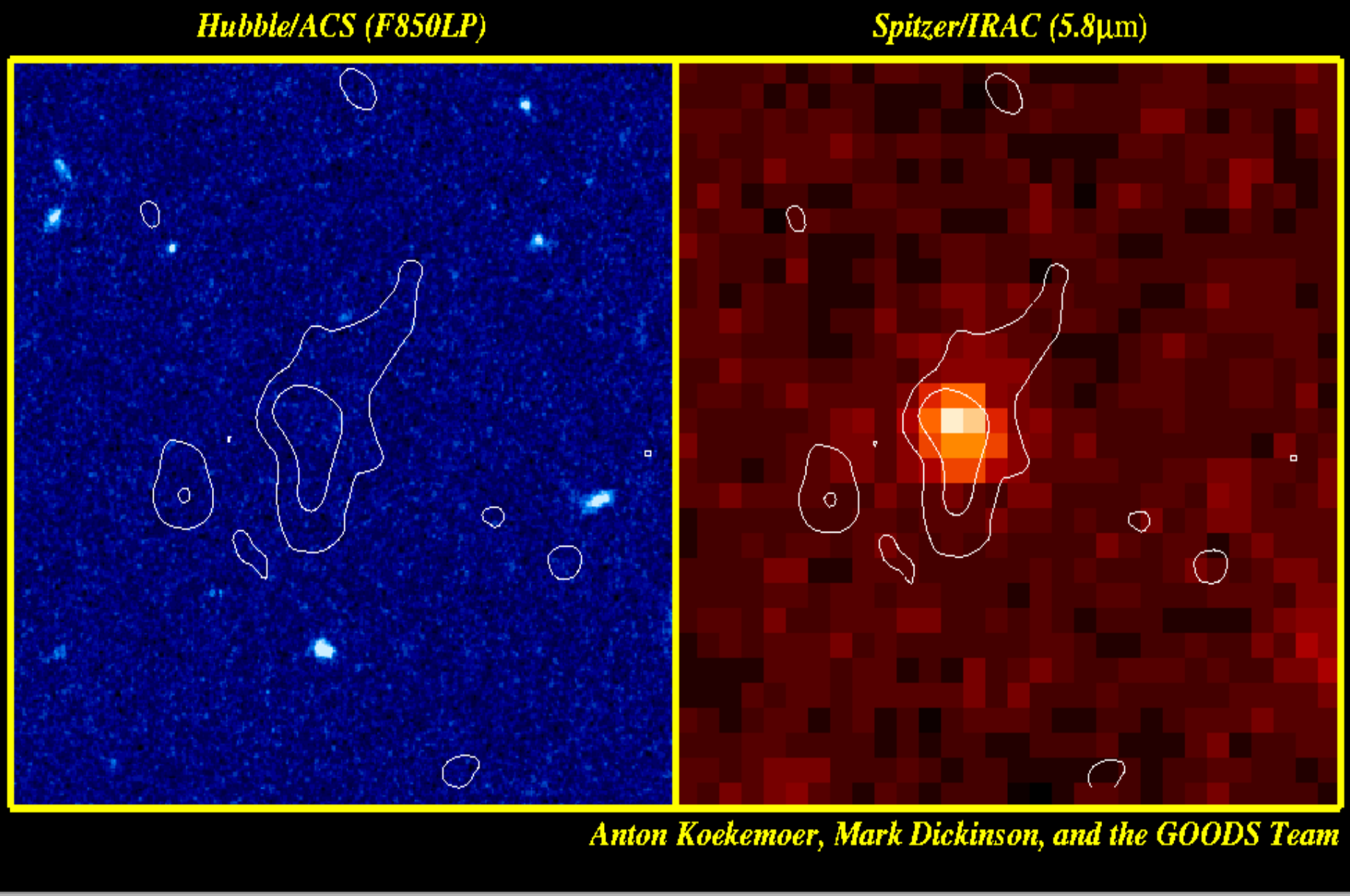
The Spitzer Space Telescope

- **Multi-purpose observatory cooled passively and with liquid-helium for astronomical observations in the infrared**
- **Launch in August 2003 for a 5+ year mission in solar orbit**
- **Three instruments use state-of-the-art infrared detector arrays**
- **Provides a >100 fold increase in infrared capabilities over all previous space missions**
- **Completes NASA's Great Observatories**
- **Major scientific and technical contributor to NASA's Origins Theme**
- **An observatory for the community. Cycle 1 Deadline was February 14, 2004. 600 proposals received.**

Assembled SIRTF Observatory at Lockheed-Martin, Sunnyvale.

Key Characteristics:

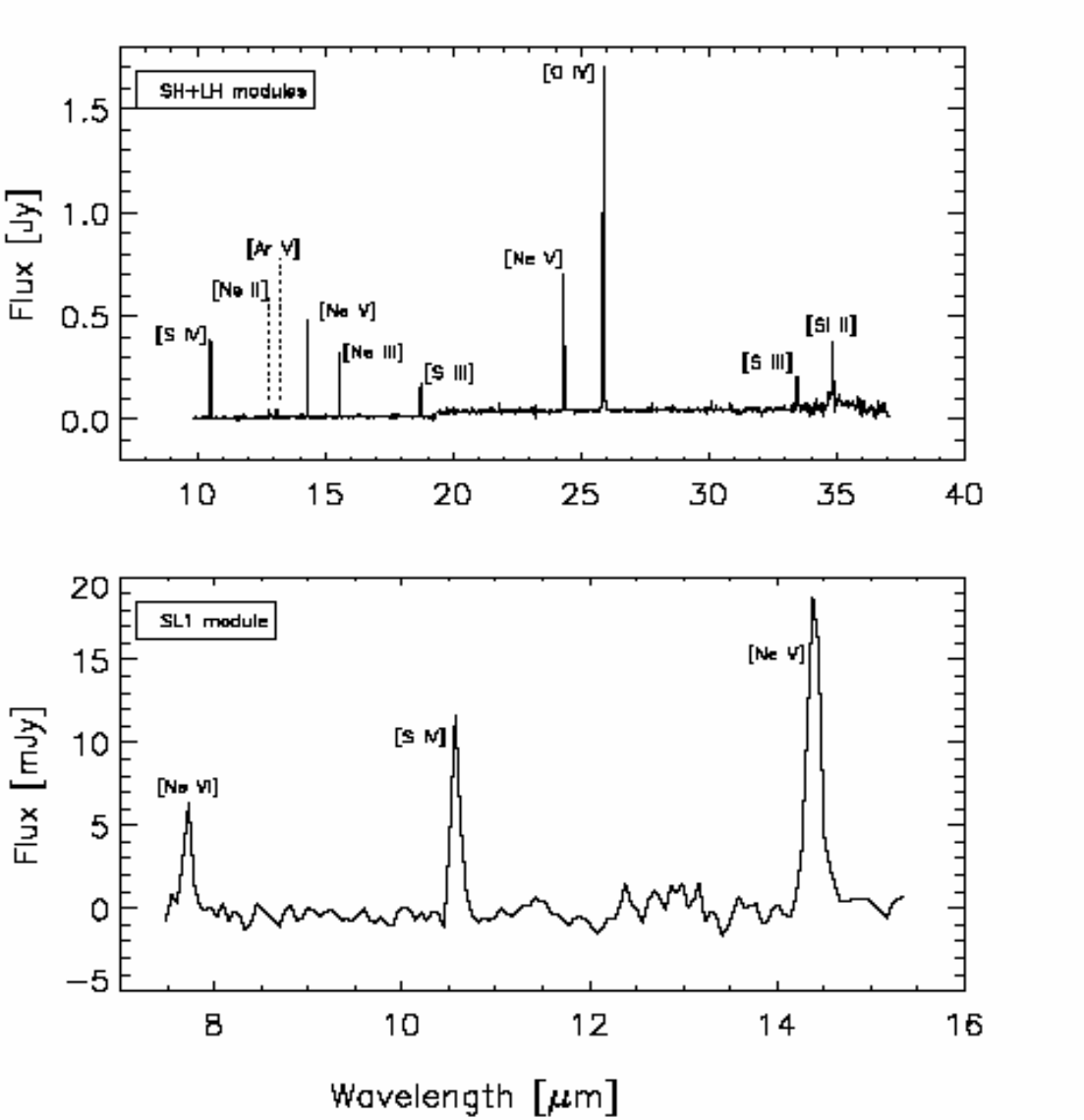
Aperture – 85 cm
Wavelength Range - 3-to-180um
Telescope Temperature – 5.5K
Mass – 870kg
Height – 4m



THE GREAT OBSERVATORIES – HST, CXO, AND SPITZER – IN ACTION. RESULTS FROM THE GOODS PROGRAM

IRS Spectra of a Planetary Nebula in the Large Magellanic Cloud

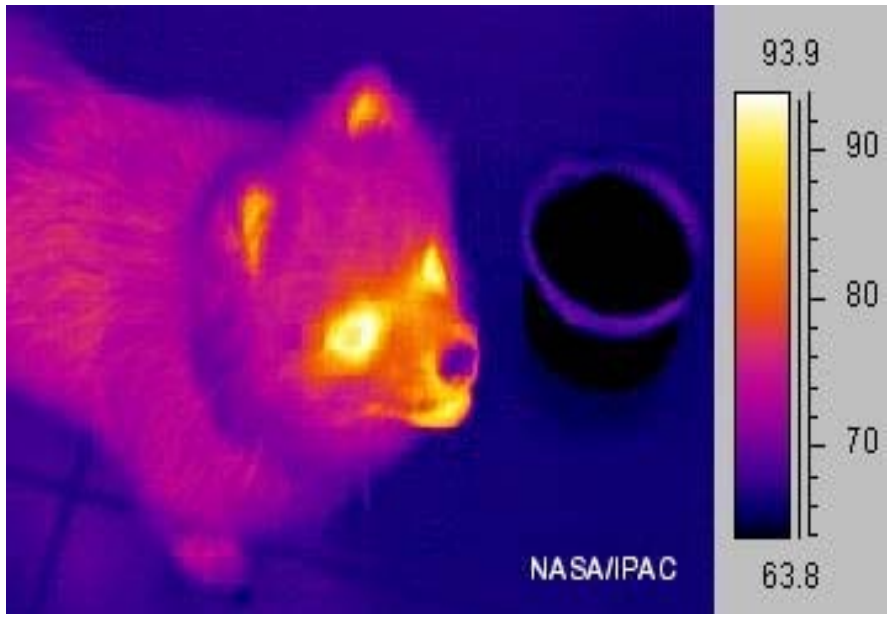
J.Bernard-Salas and the IRS team



Rusty the Dog

Visible Light

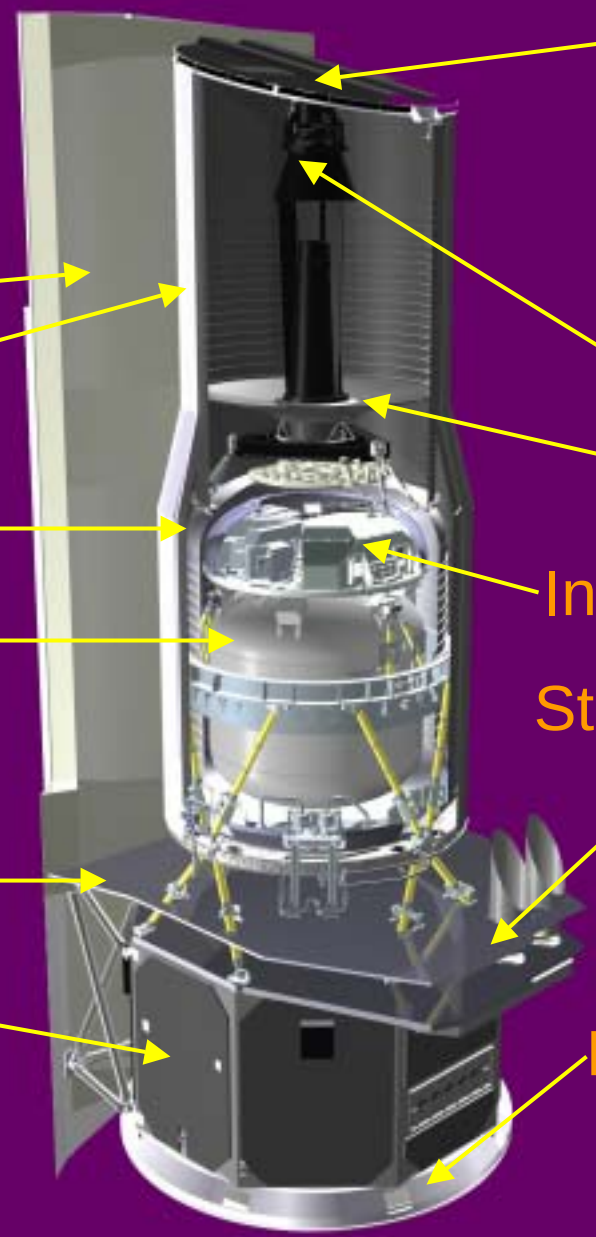
Infrared Light



Visit the Infrared Zoo at:

http://coolcosmos.ipac.caltech.edu/image_galleries/ir_zoo/index.html

Cutaway View of the Spitzer Space Telescope



Dust Cover

Solar Panel

Solar Panel Shield

Outer Shell

Secondary Mirror

Primary Mirror

Cryostat

Instrument Chamber

Helium Tank

Startrackers & Gyros

Spacecraft Shield

Spacecraft Bus

High Gain Antenna

Cutaway provided by Ball Aerospace

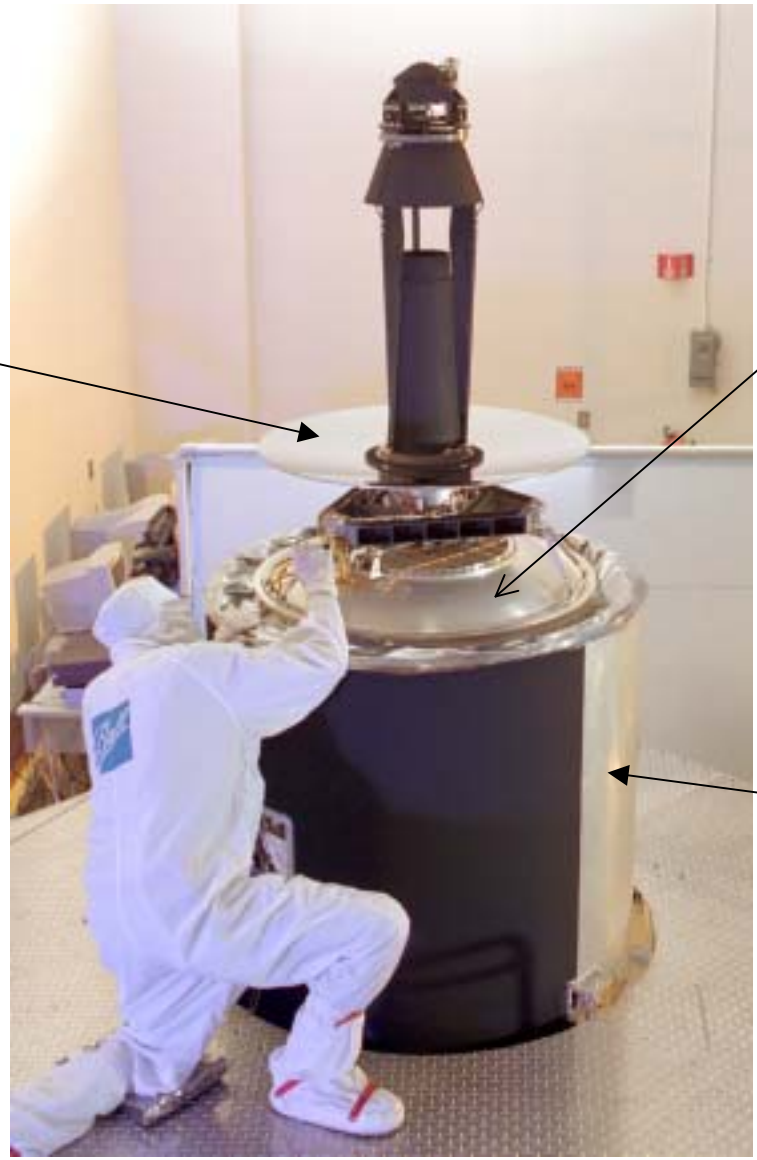
Spitzer's Instruments and Principal Investigators

IRS
[infrared spectrograph]
J.Houck
Cornell

MIPS
[multiband imaging photometer]
G.Rieke
Arizona

IRAC
[infrared array camera]
G.Fazio
Harvard/ SAO

Assembly of the Heart of the CTA



The Spitzer Observatory Fully Assembled (w/o Solar Array)

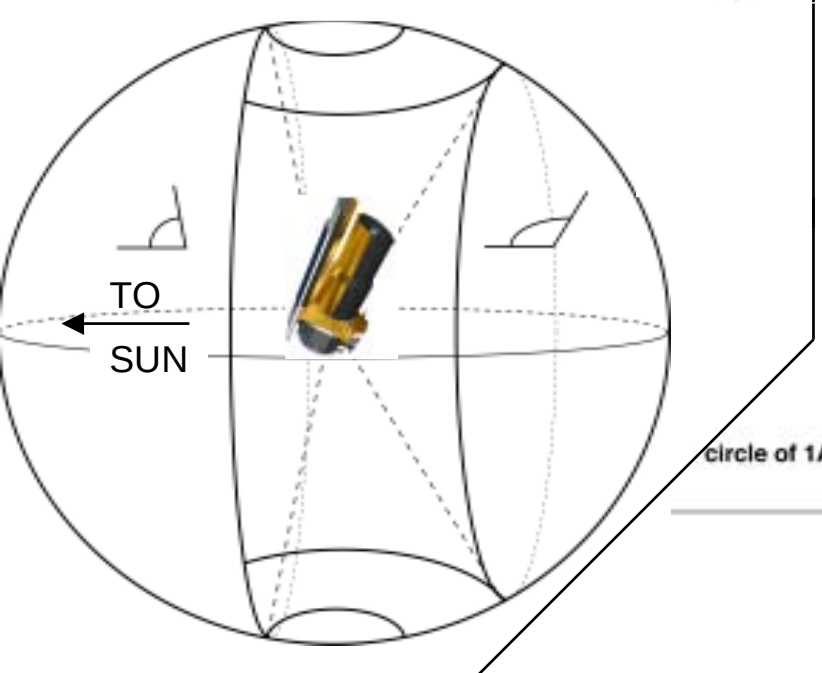
Spitzer at the Cape

August 25, 2003 - WE'RE OFF!

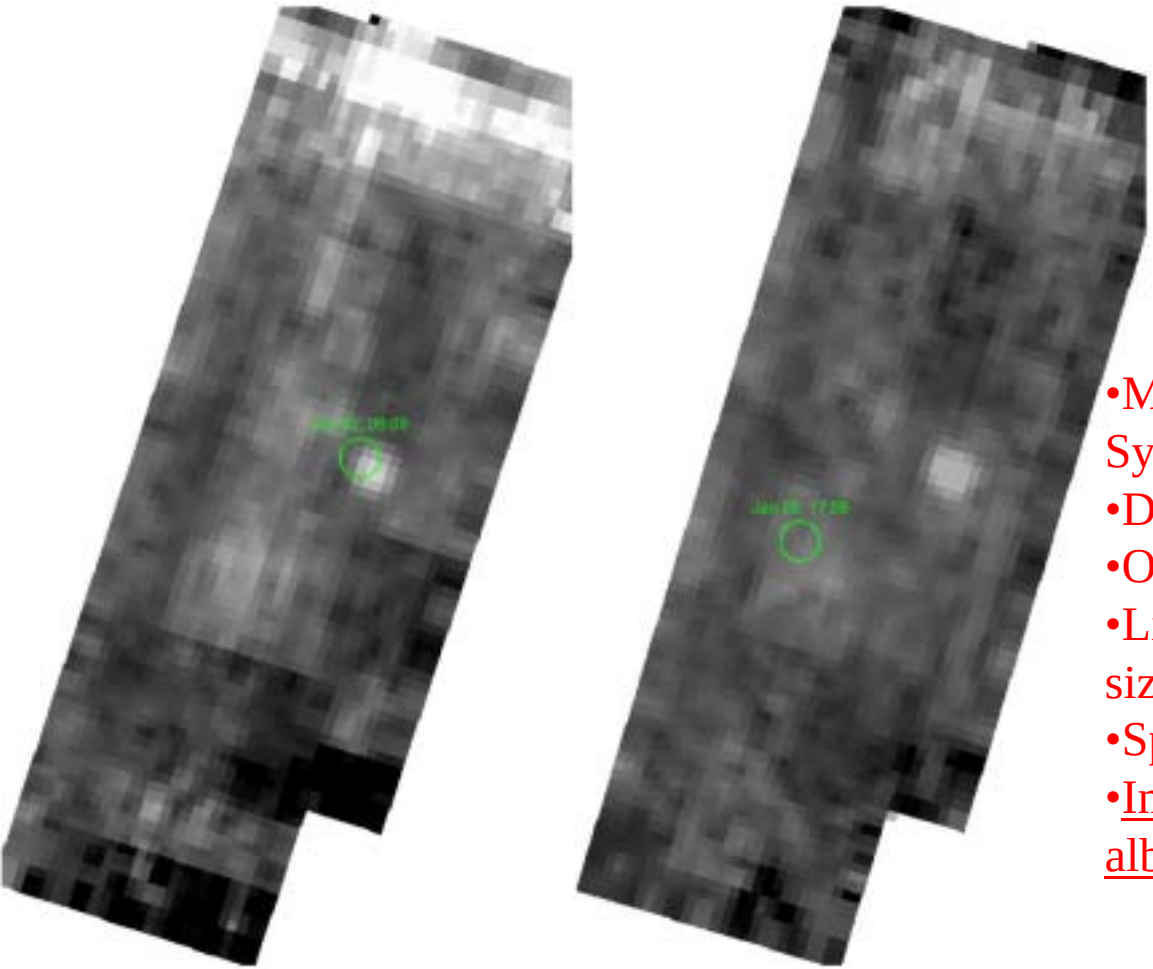
Where's Spitzer Now?

(Mark Garcia, JPL)

Spitzer can observe anywhere within annulus between 80 and 120 degrees off sun (~35% of sky)



Exploring the Outer Solar System: MIPS 70um Observations of Sedna

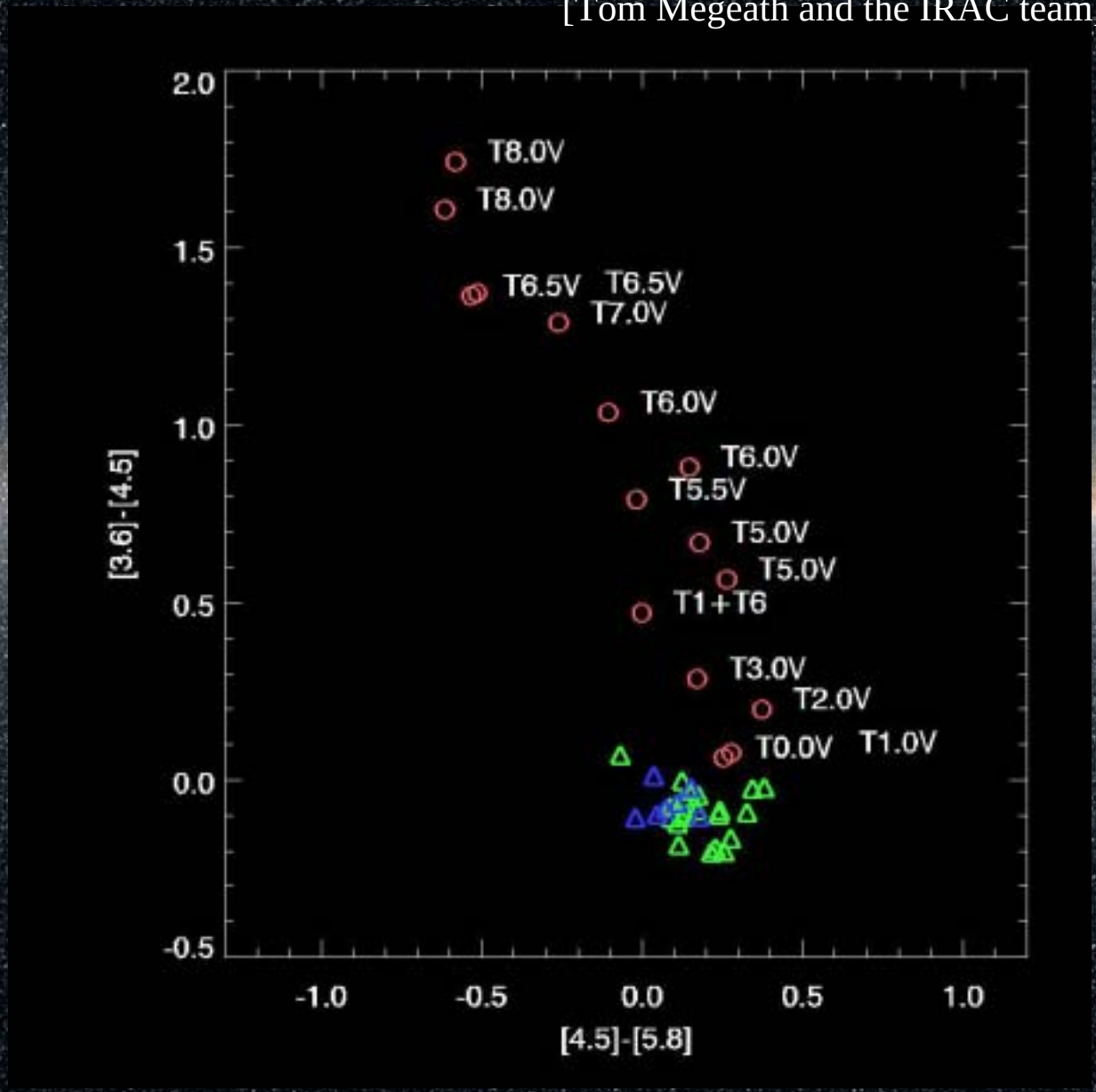


- Most distant object known in Solar System – 90 au from the sun
- Discovered by Mike Brown – Nov 03
- Observed @70 μm w/Spitzer Jan 04
- Limit on 70 μm flux density implies size less than 1100 km (<0.02”)
- Spitzer result confirmed by HST
- Implication: SEDNA has higher albedo than expected!

Limiting flux <~10mJy @ 70um, which is ~30x fainter than the IRAS faint source catalog

IRAC Colors of Brown Dwarfs

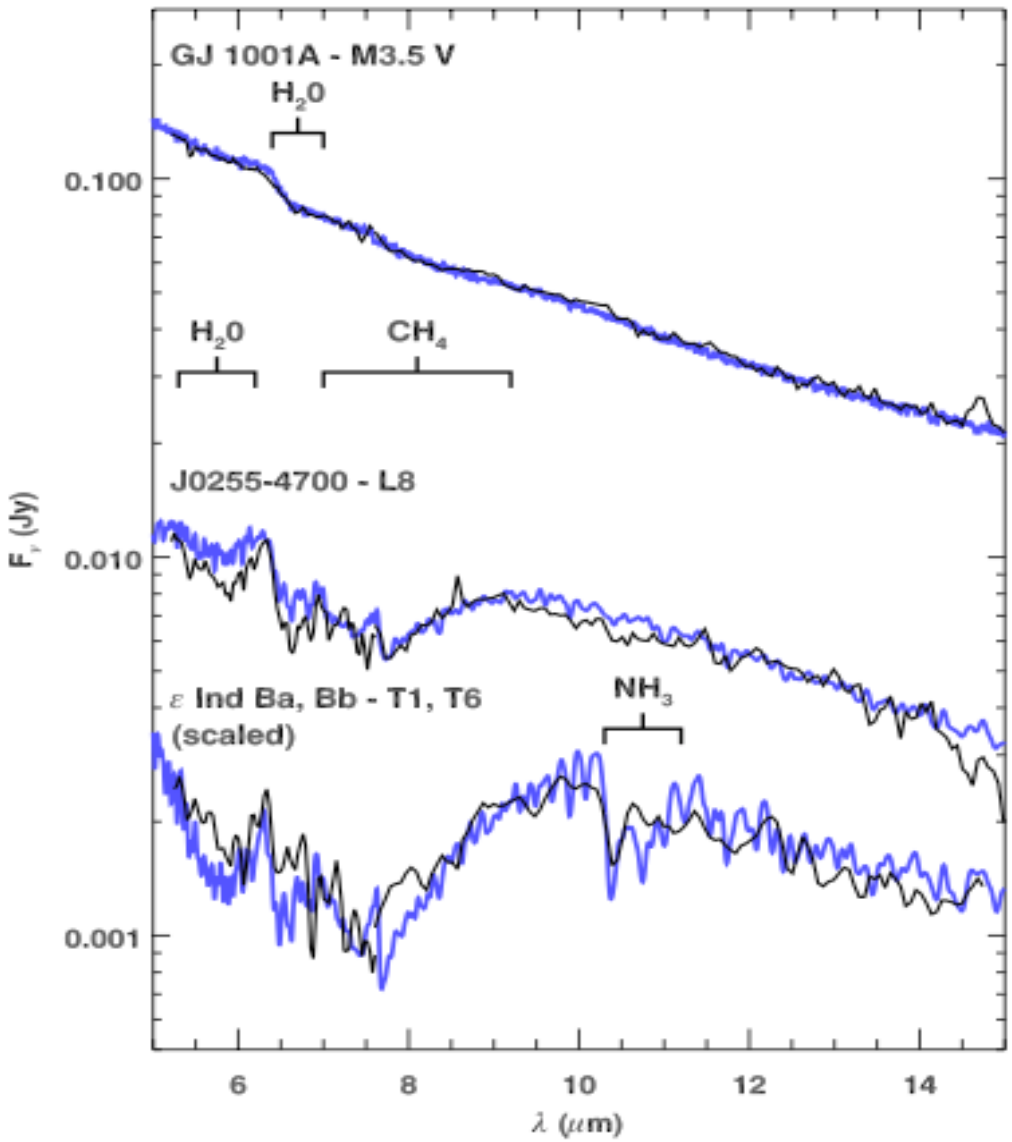
[Tom Megeath and the IRAC team]



A strong dependence of the [3.6]-[4.5] color with spectral type is demonstrated by the IRAC data. *Patten et al in prep.*

Circle: T-dwarf
Diamond: L-dwarf
Triangle: M-dwarf

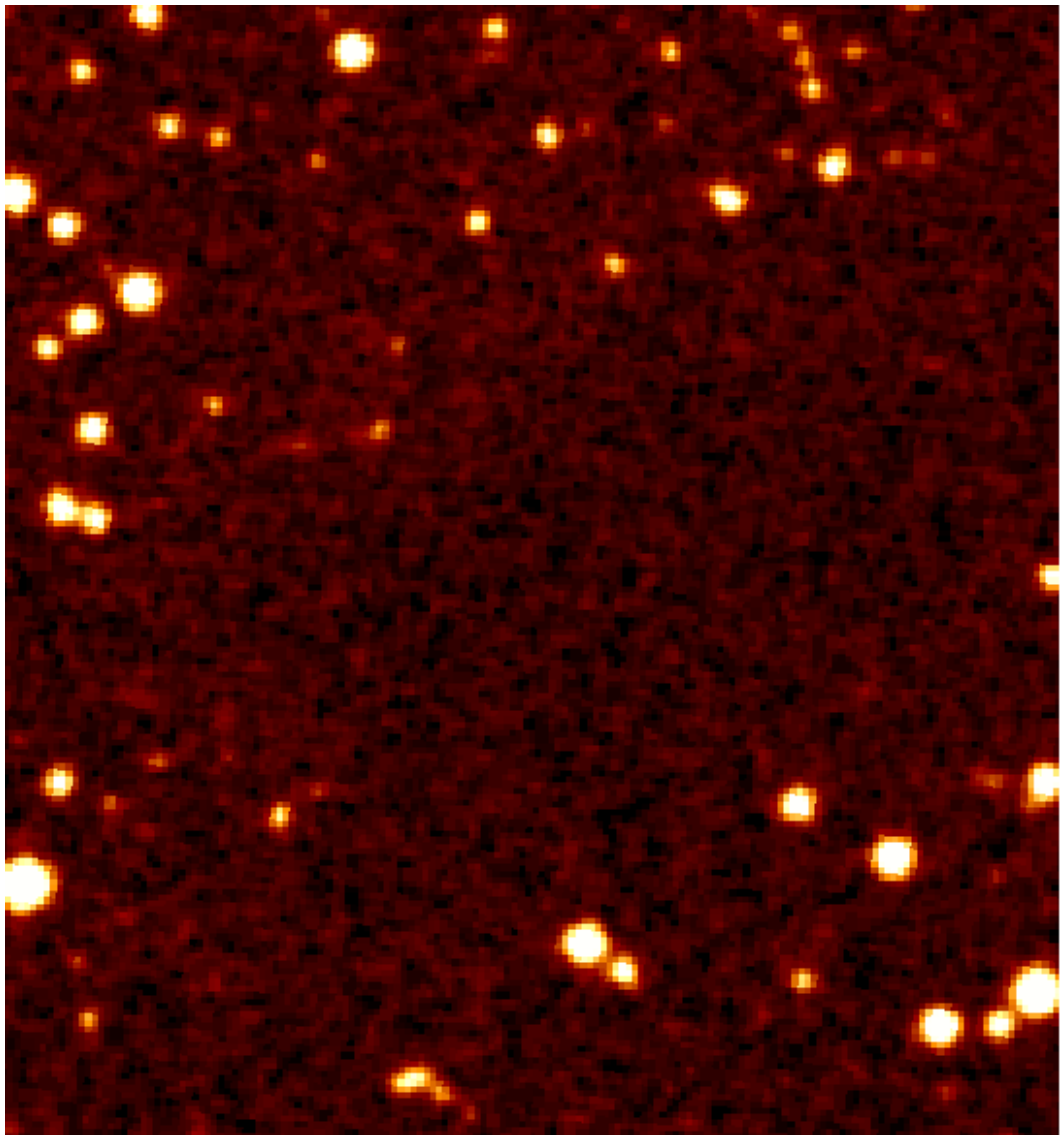
Brown Dwarf Spectra [Tom Roellig et al]



Black – Data

Blue – Models from Marley and Saumon

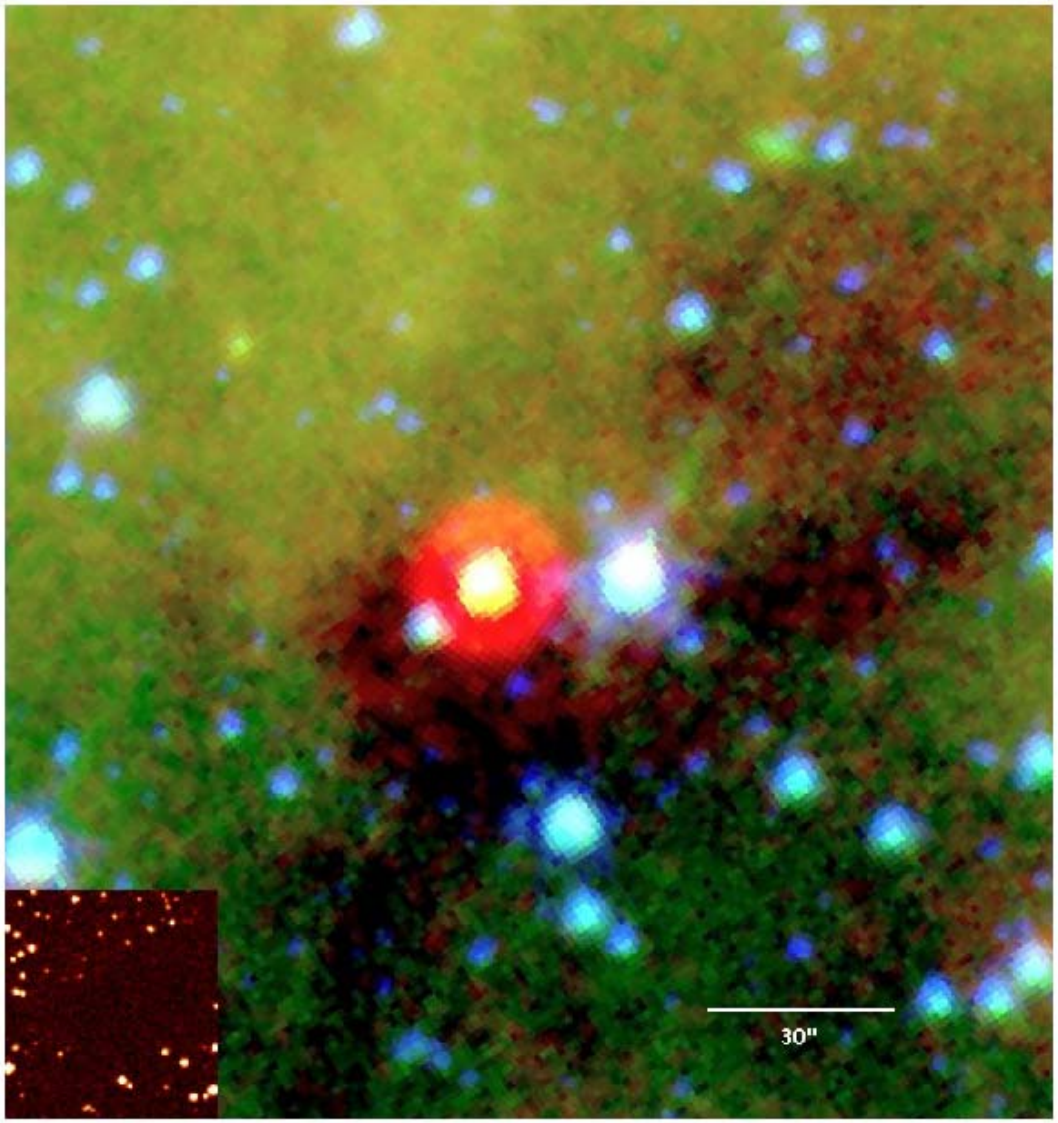
A Typical Starless Core [Neal Evans & c2d team]



L1014 distance ~ 200 pc, but somewhat uncertain.

R-band image from DSS

A Surprise from Spitzer



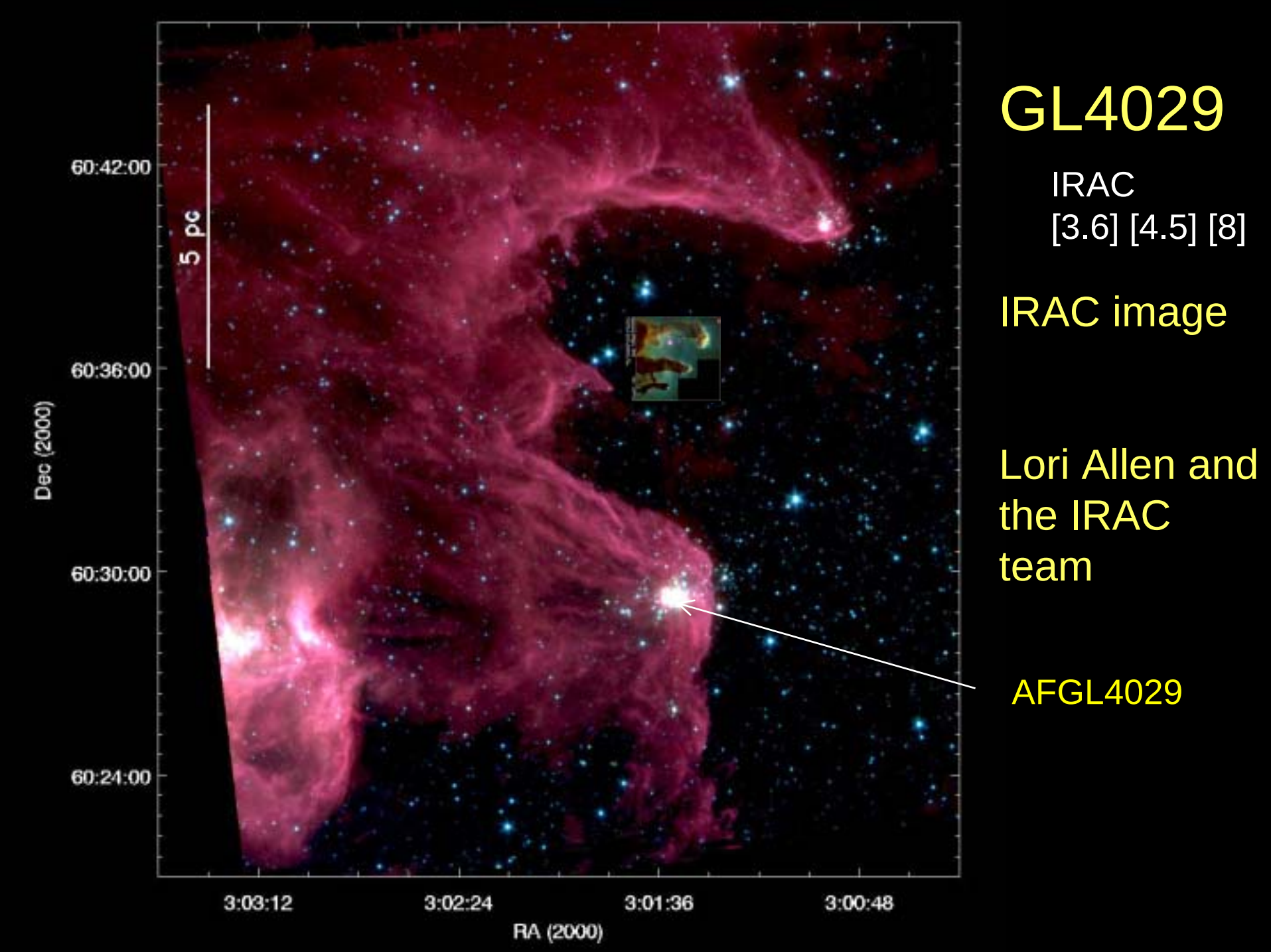
Three Color Composite:
Blue = 3.6 microns
Green = 8.0 microns
Red = 24 microns

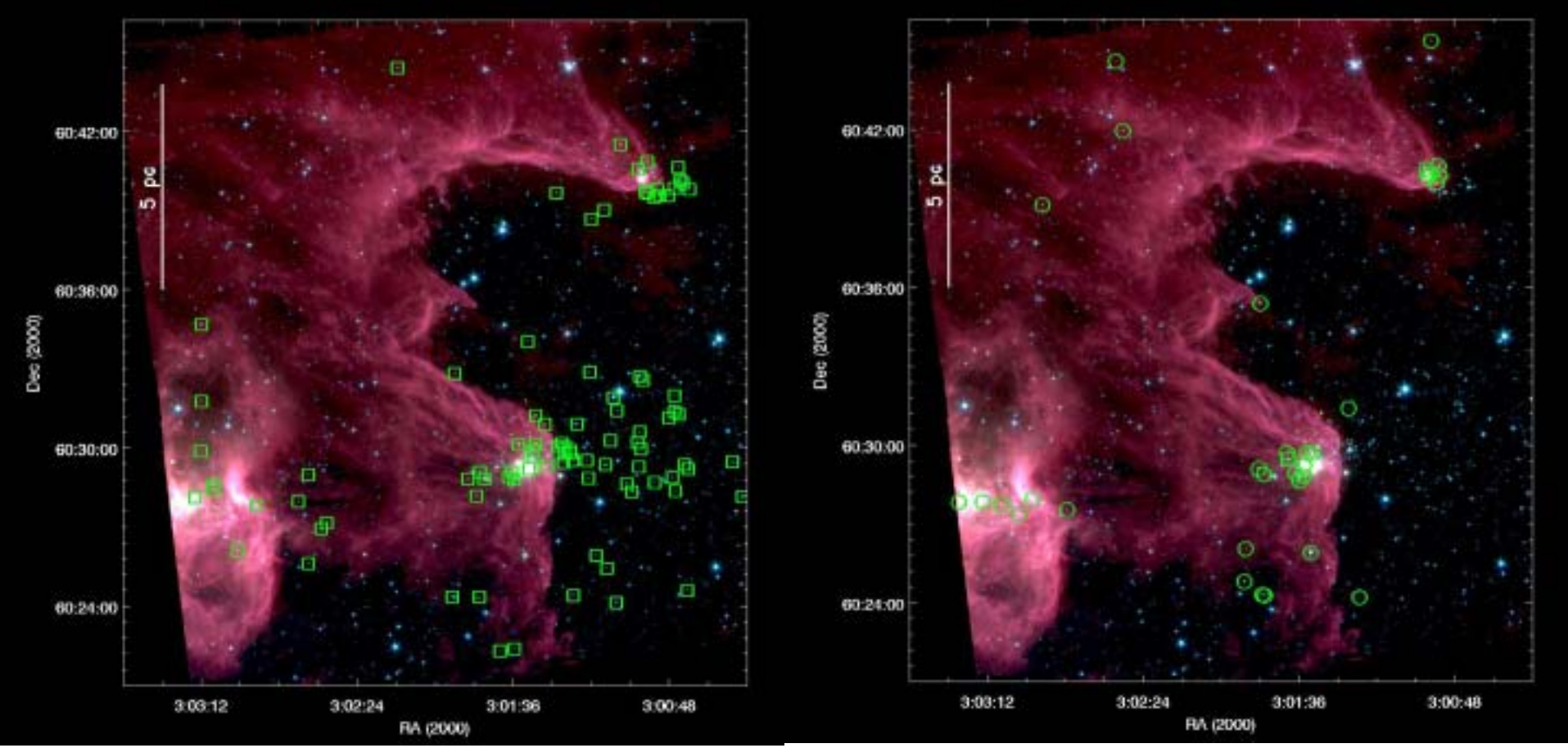
R-band image from DSS at Lower left.

We see many stars through the cloud not seen in R. The central source is NOT a background star.

L1014 is not “source-less”. Larger size in red is PSF.

C. Young et al. ApJS, in press

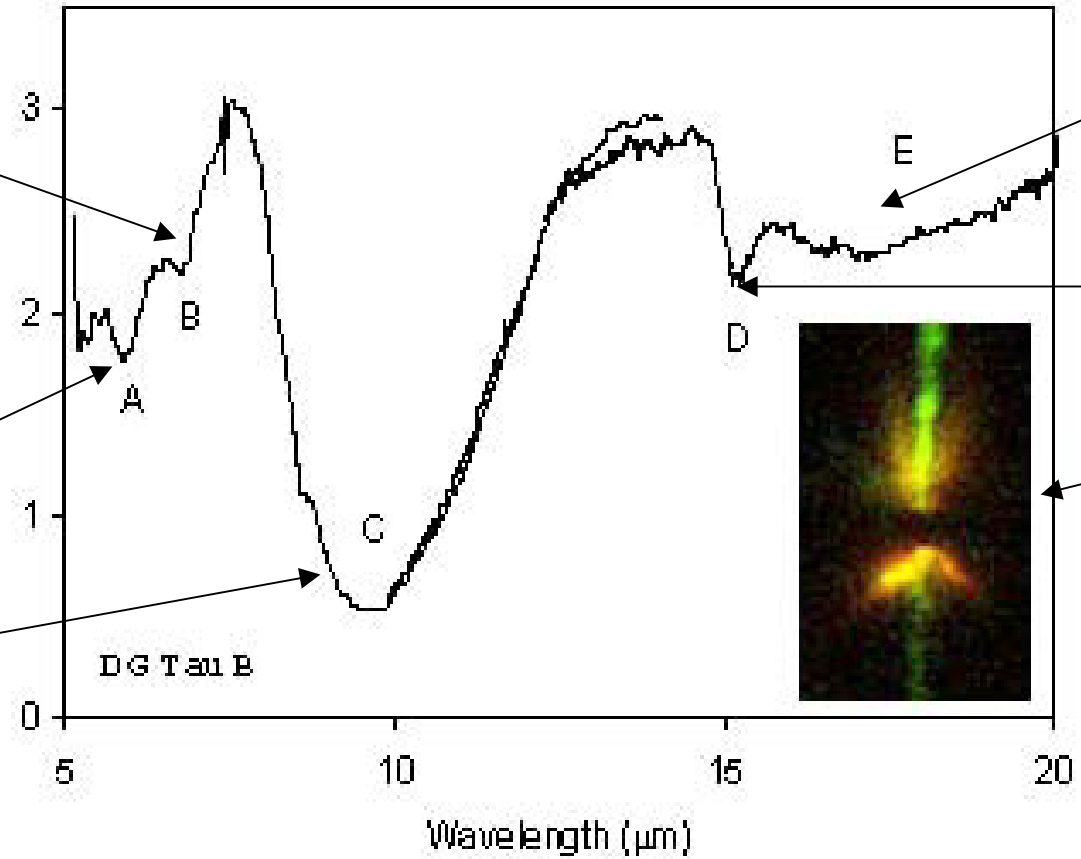

GL4029
IRAC
[3.6] [4.5] [8]
IRAC image
Lori Allen and the IRAC team
AFGL4029
5 pc
60:42:00
60:36:00
60:30:00
60:24:00
Dec (2000)
3:03:12
3:02:24
3:01:36
3:00:48
RA (2000)



GL4029 with class I [left] and class 0 [right] candidate protostars indicated

Spitzer Sees Organic Materials in Protoplanetary Disks

Spitzer Spectrum of Solar-type Young Star/Disk System in Taurus:



Methyl Alcohol ice

Water ice

Silicates

Silicates

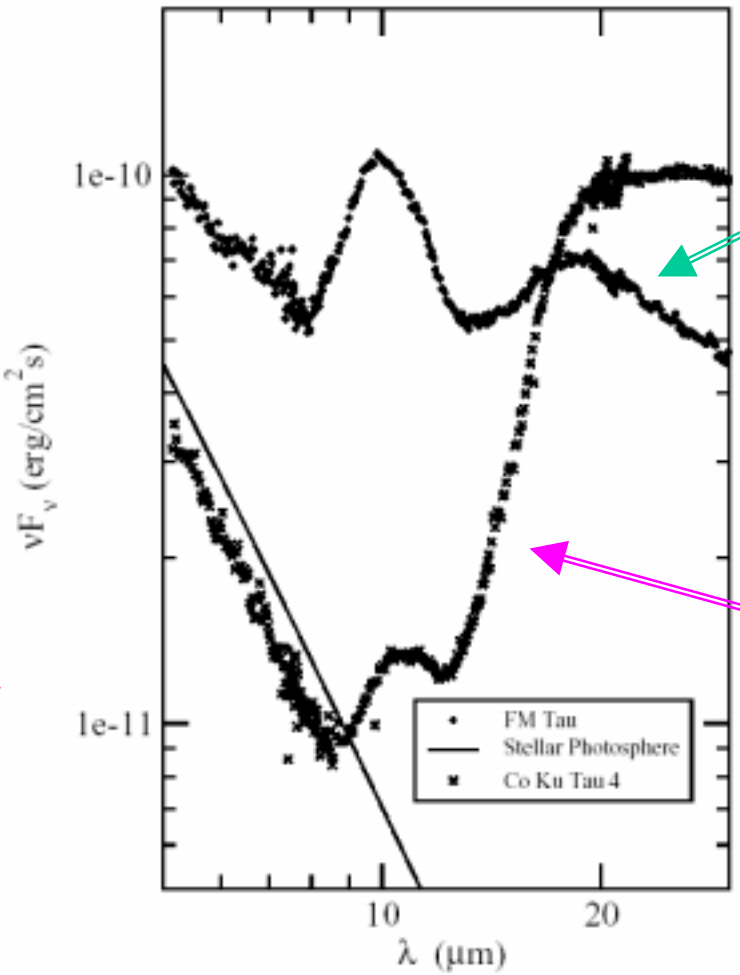
CO_2 ice

HST image

~200 such Star/Disk systems have been identified in RCW49 images alone!

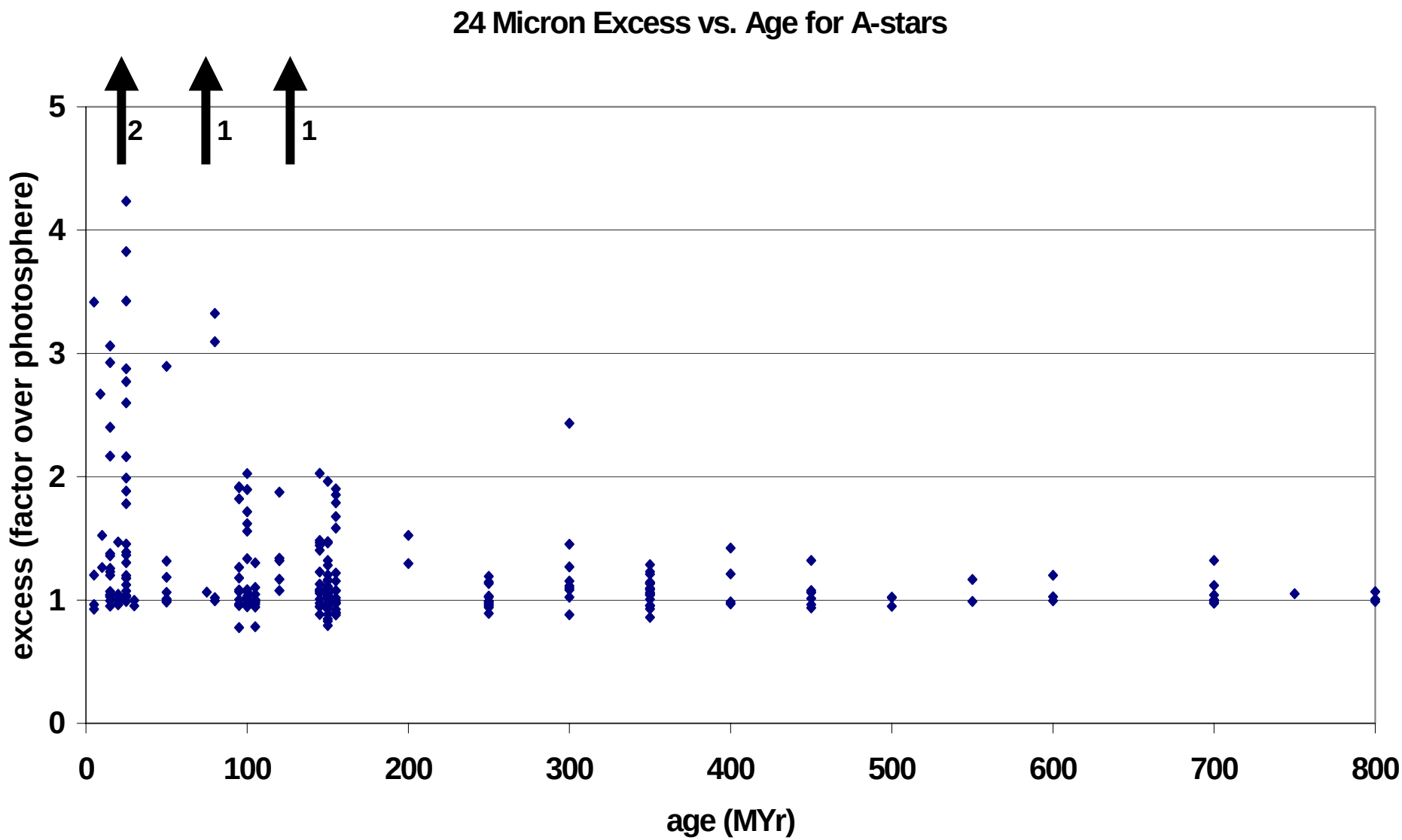
Spitzer Spectra of T Tauri stars (Forrest, Watson et al)

CoKu Tau 4 spectrum shows evidence of central clearing, perhaps due to formation of a planet about 6au from the star.



Temporal decay of planetary/protoplanetary disks

George Rieke, MIPS

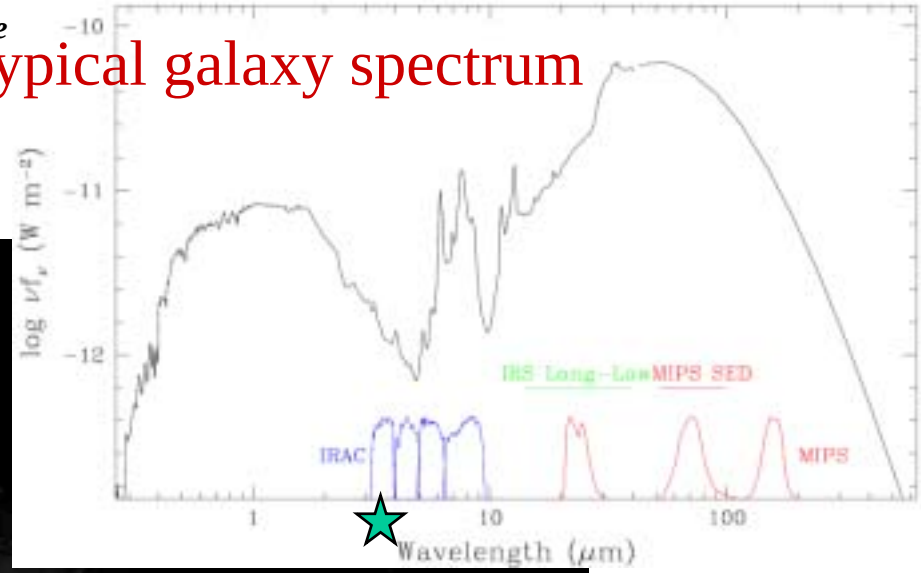



M81 Galaxy
Visible

JPL

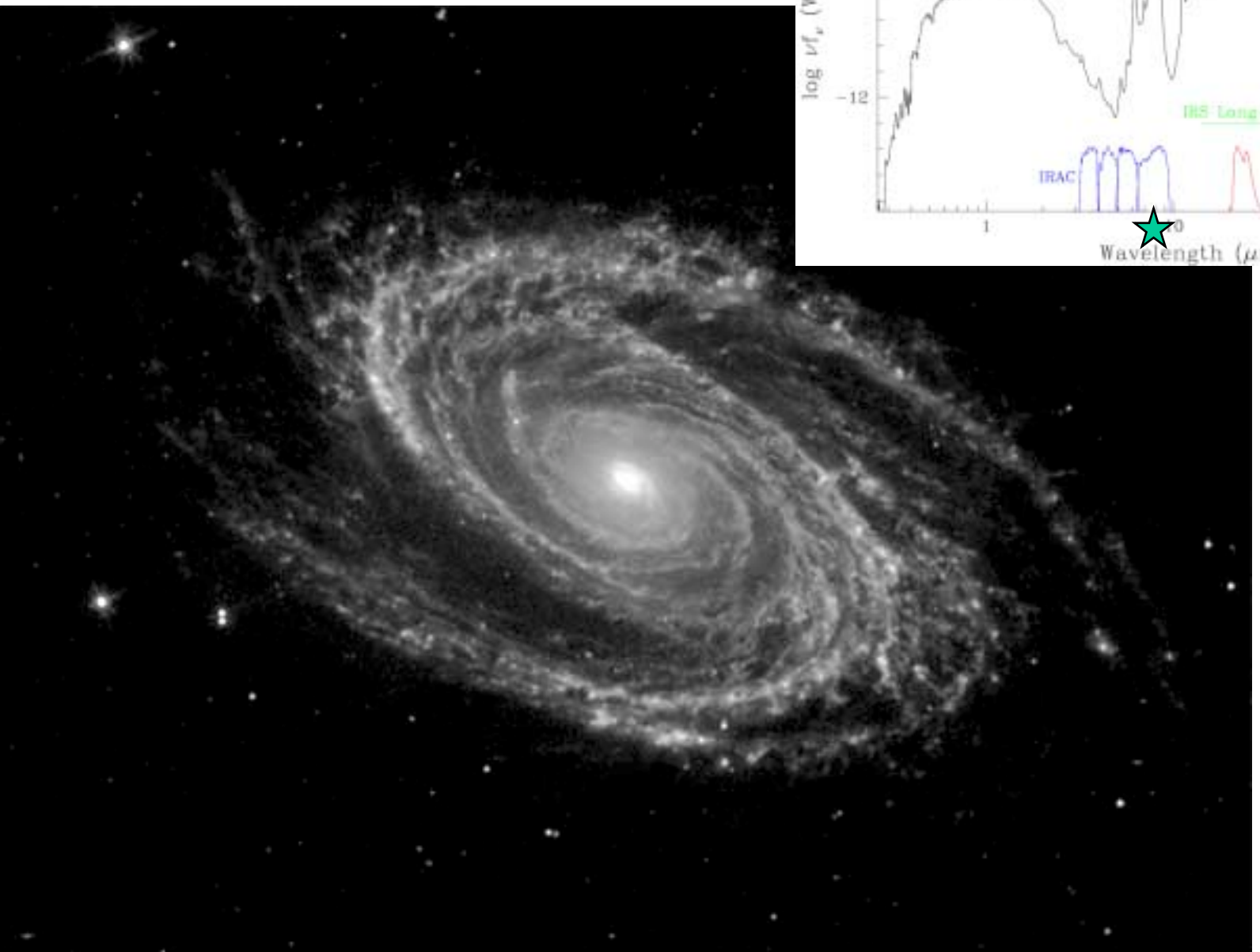
Spitzer 3. 6μm

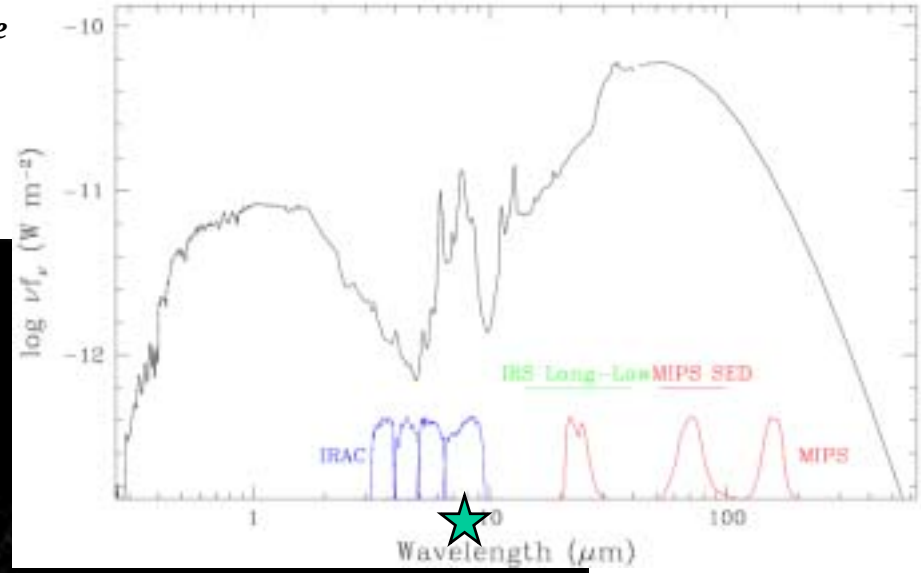
Typical galaxy spectrum



JPL

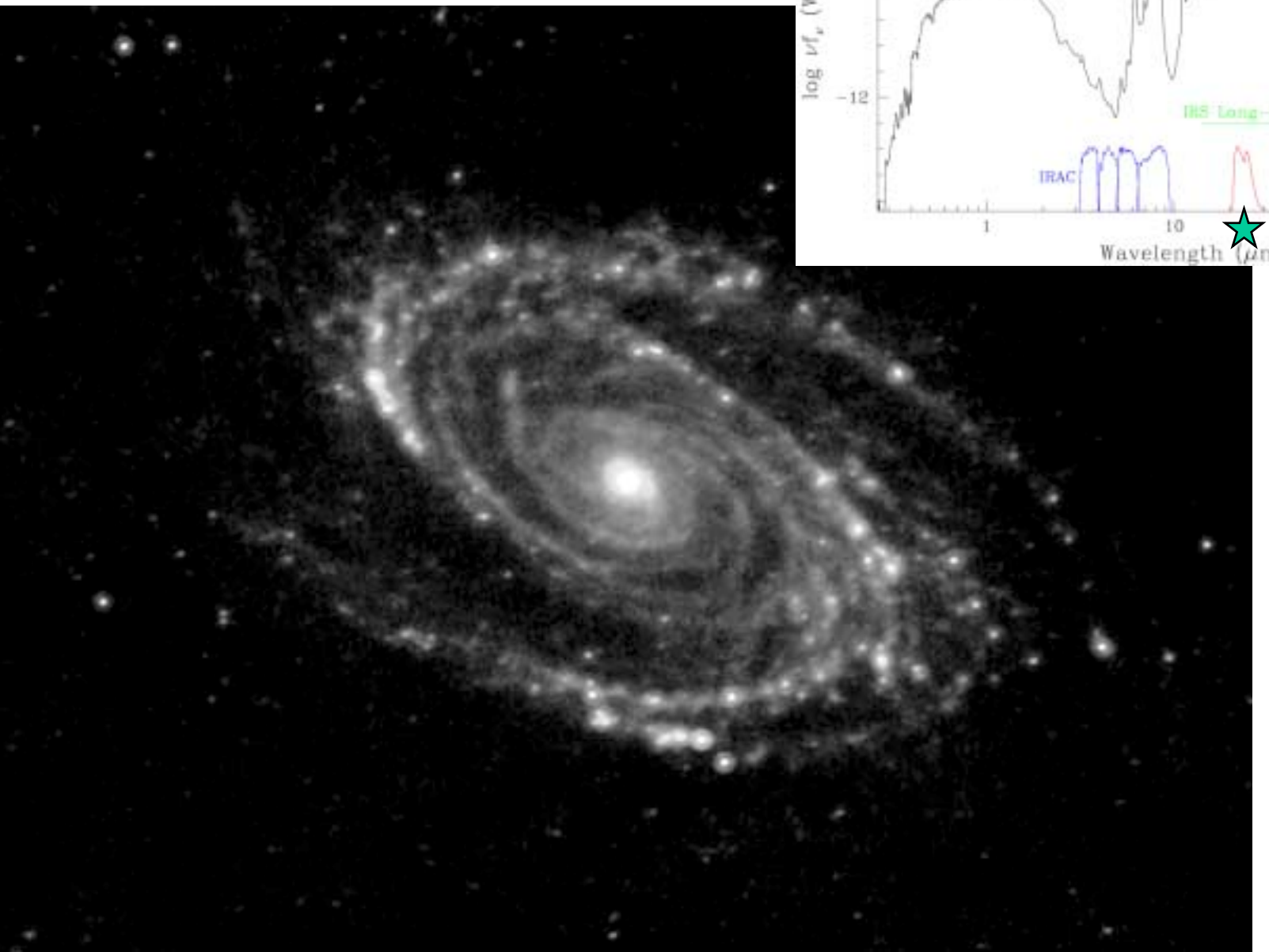
Spitzer 8μm

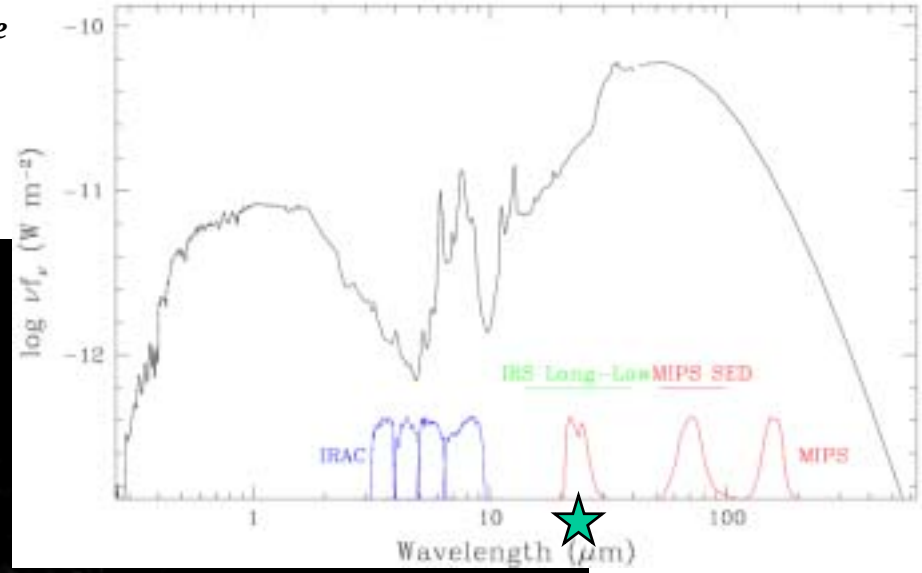


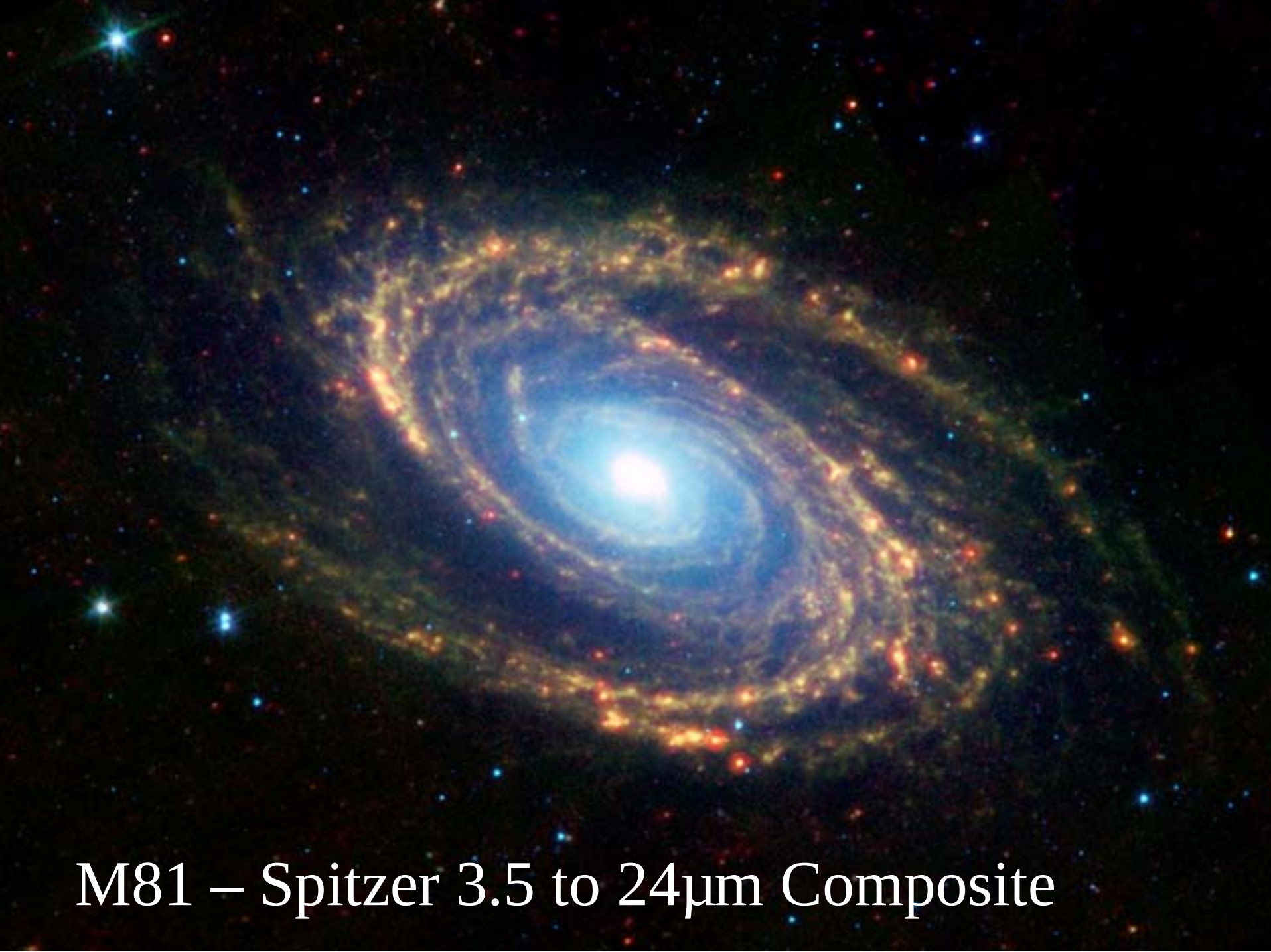


JPL

Spitzer 24μm



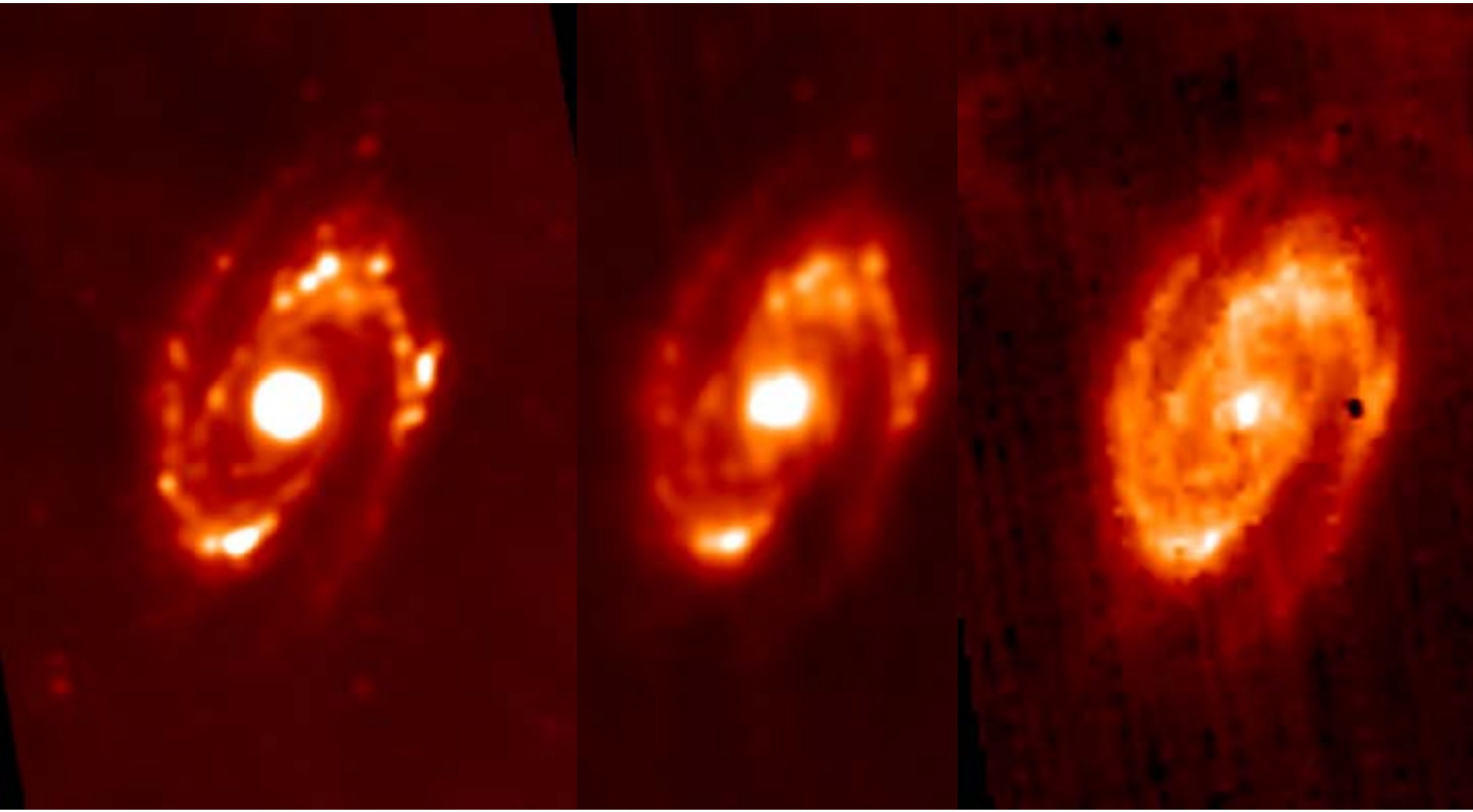




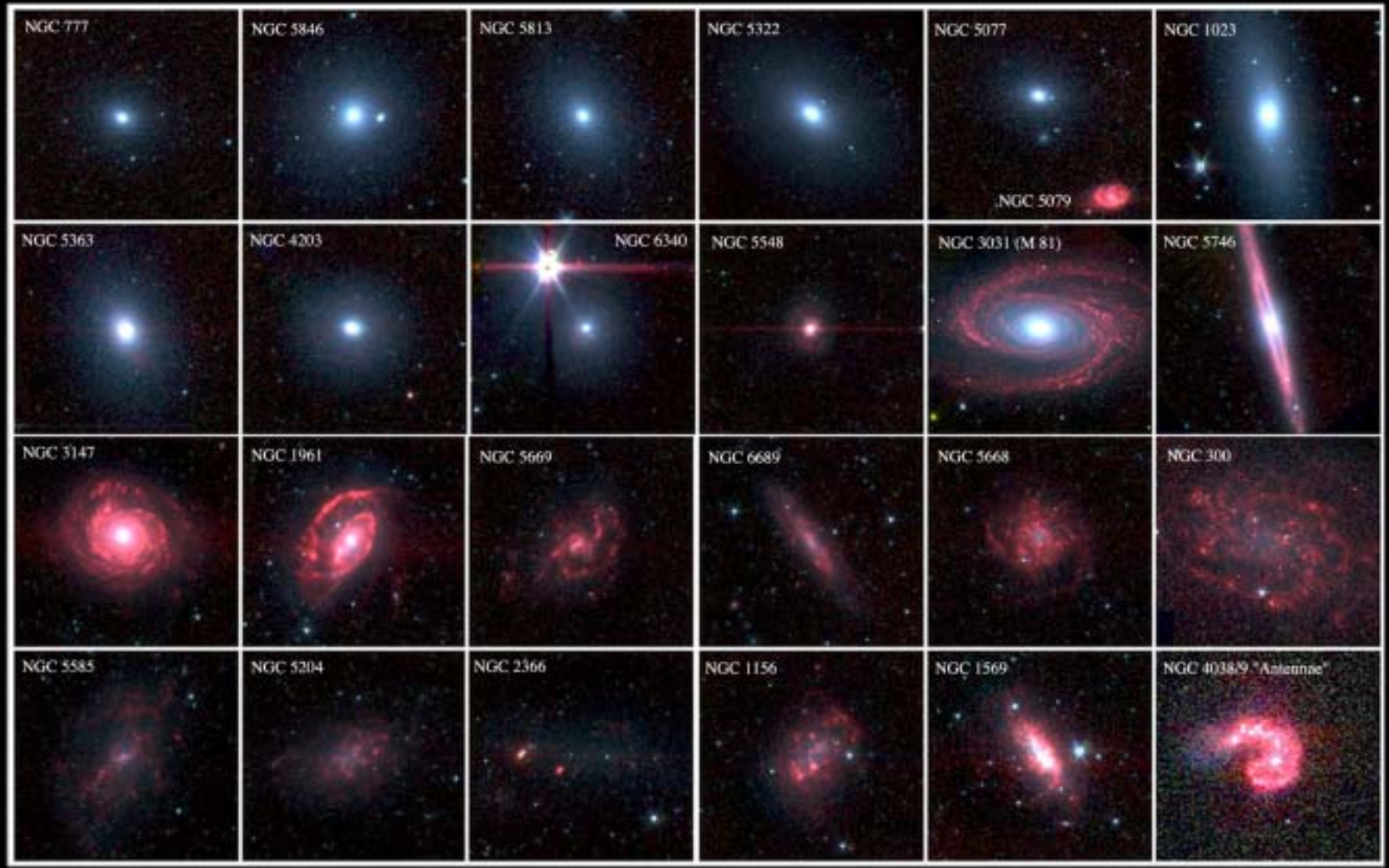
M81 – Spitzer 3.5 to 24μm Composite

M81: MIPS Trifecta at 160um Resolution

K.Gordon, MIPS/Arizona



24um 70um 160um

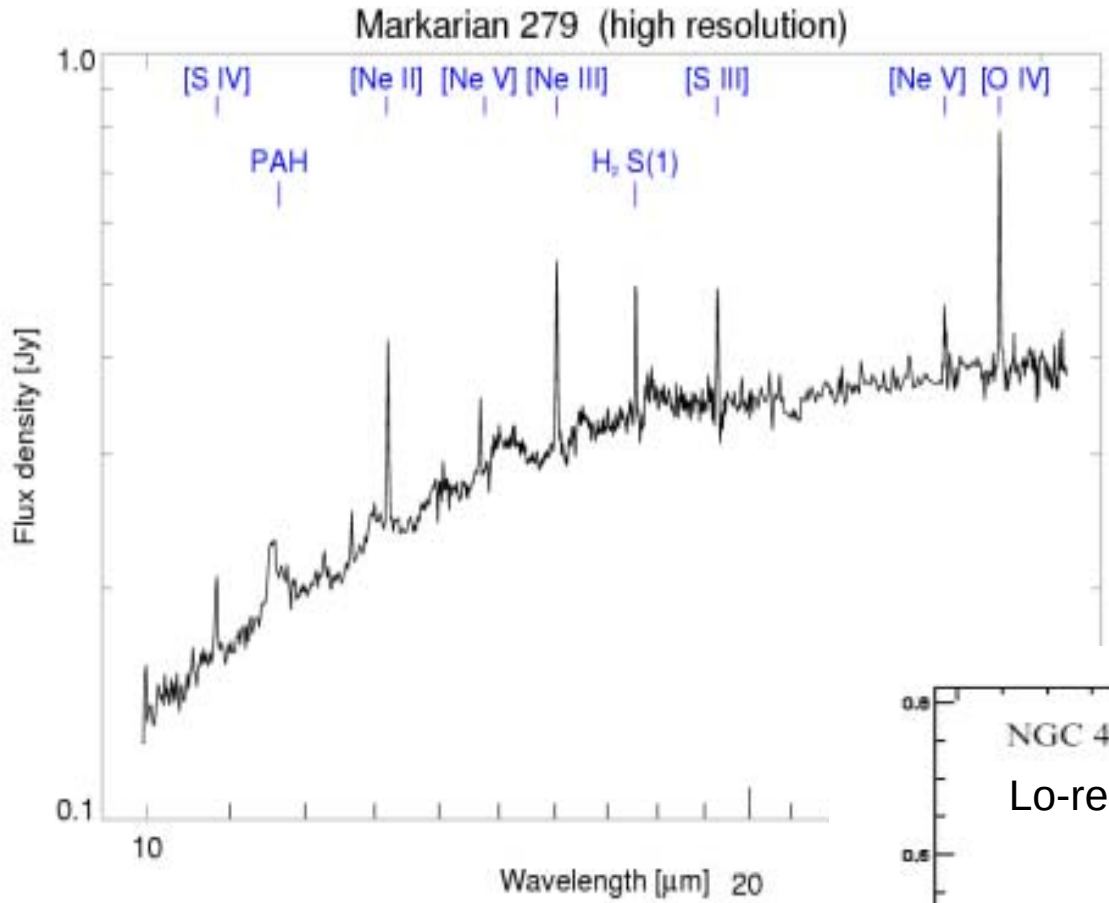


Infrared Mosaic of Nearby Galaxies

Spitzer Space Telescope • IRAC

M. A. Pahre & G. G. Fazio (SAO) / NASA / JPL-Caltech

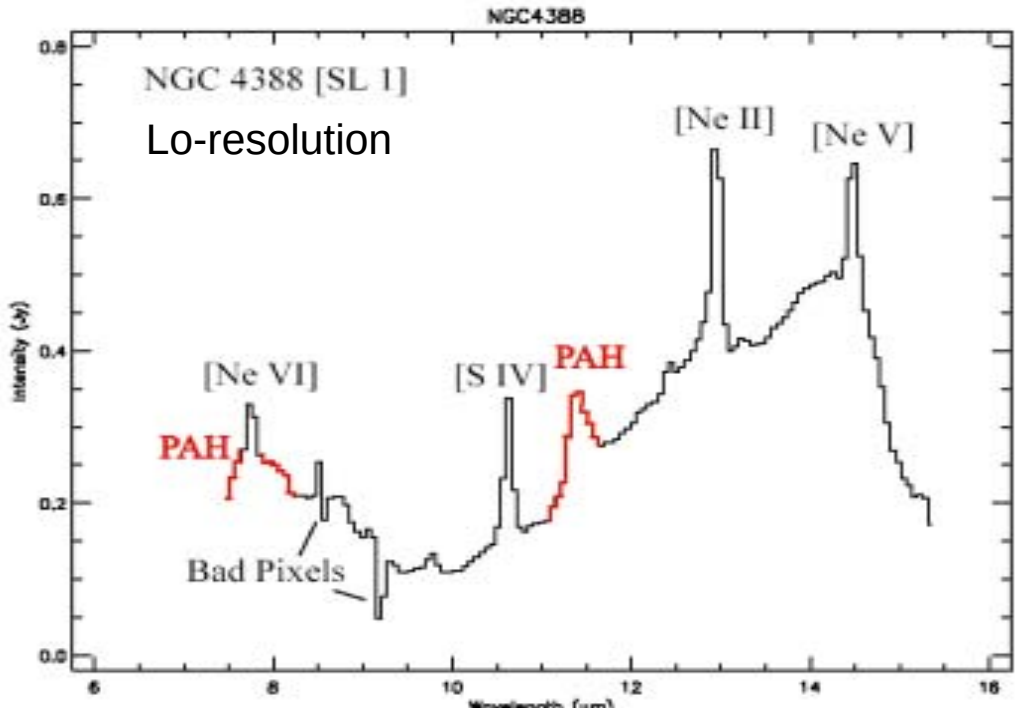
sao-2004-19



IRS spectra show both starburst and AGN diagnostics

B.Brandl (IRS/Cornell+Leiden)

V. Gorjian (JPL)

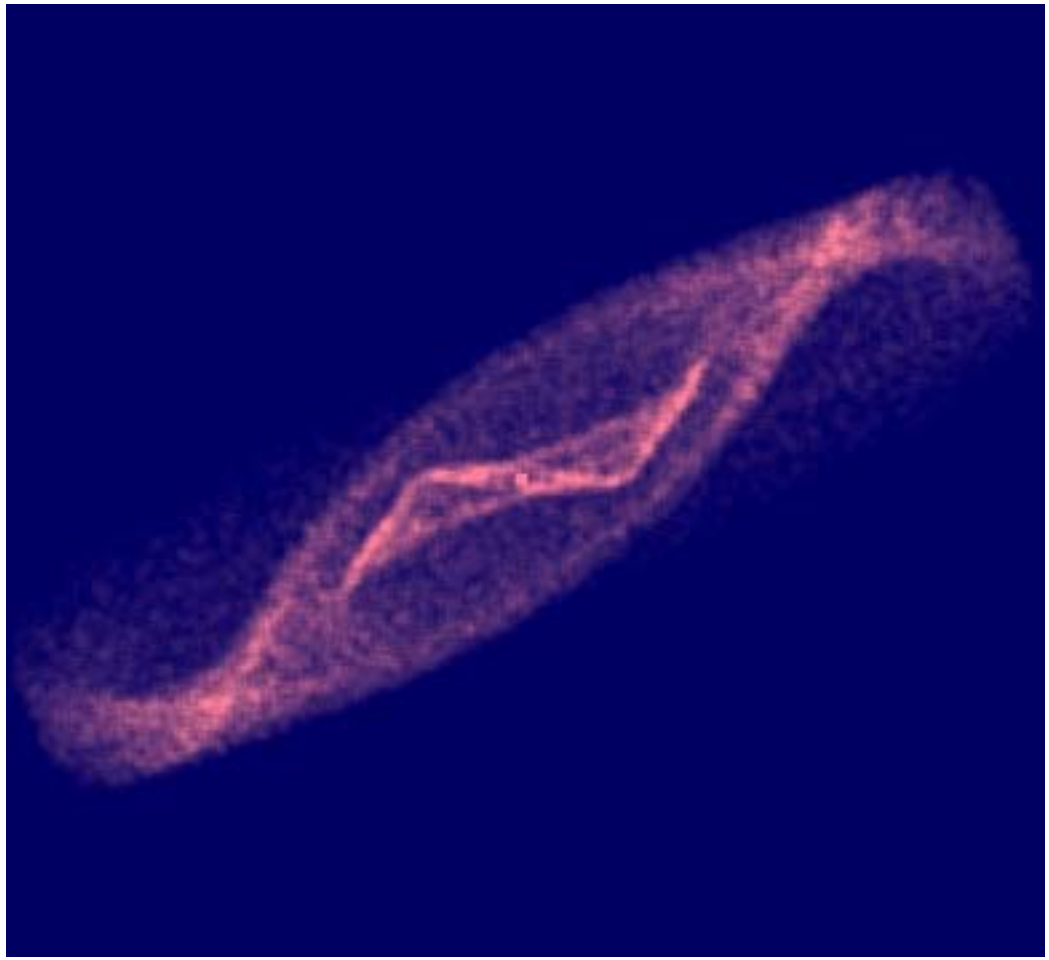


NGC 5128 - Centaurus A
Galactic Cannibalism in Action

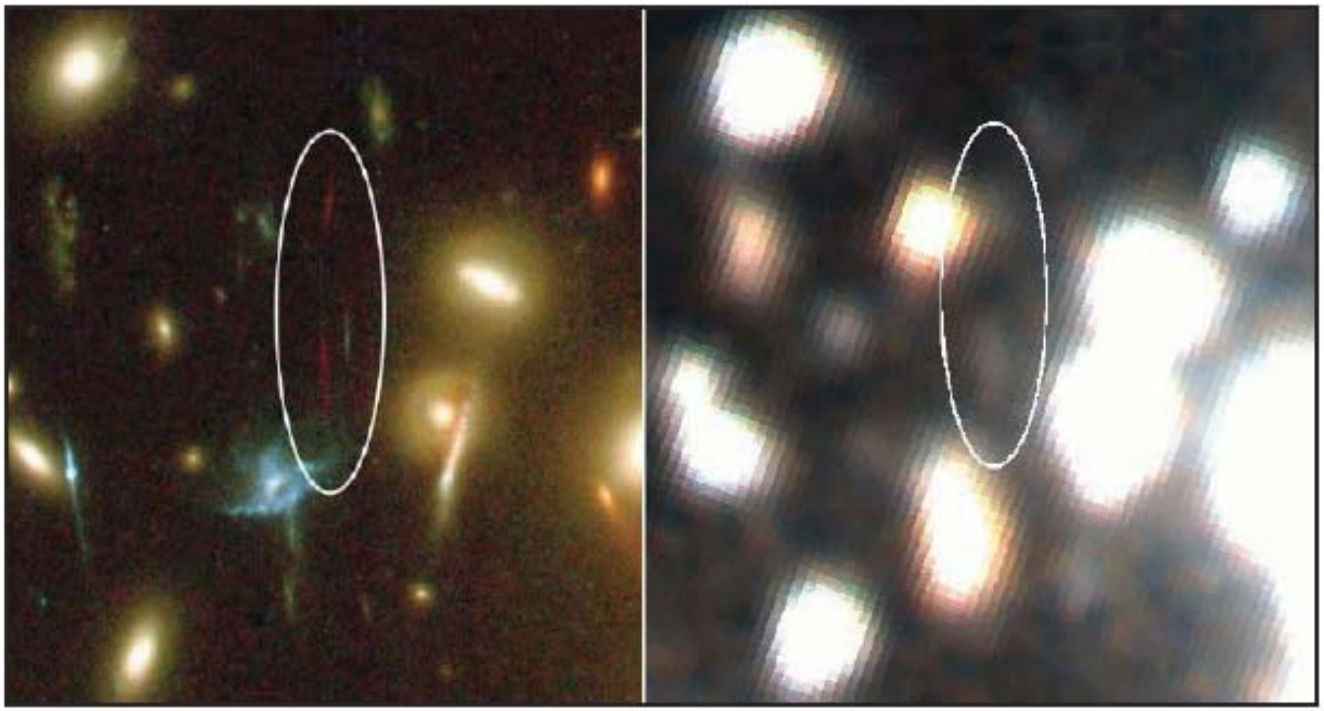
Cen A – Inside the Cannibal

Model of Warped Disk

produced by Alice Quillen



Spitzer Telescope Weighs and Dates a Primeval Galaxy



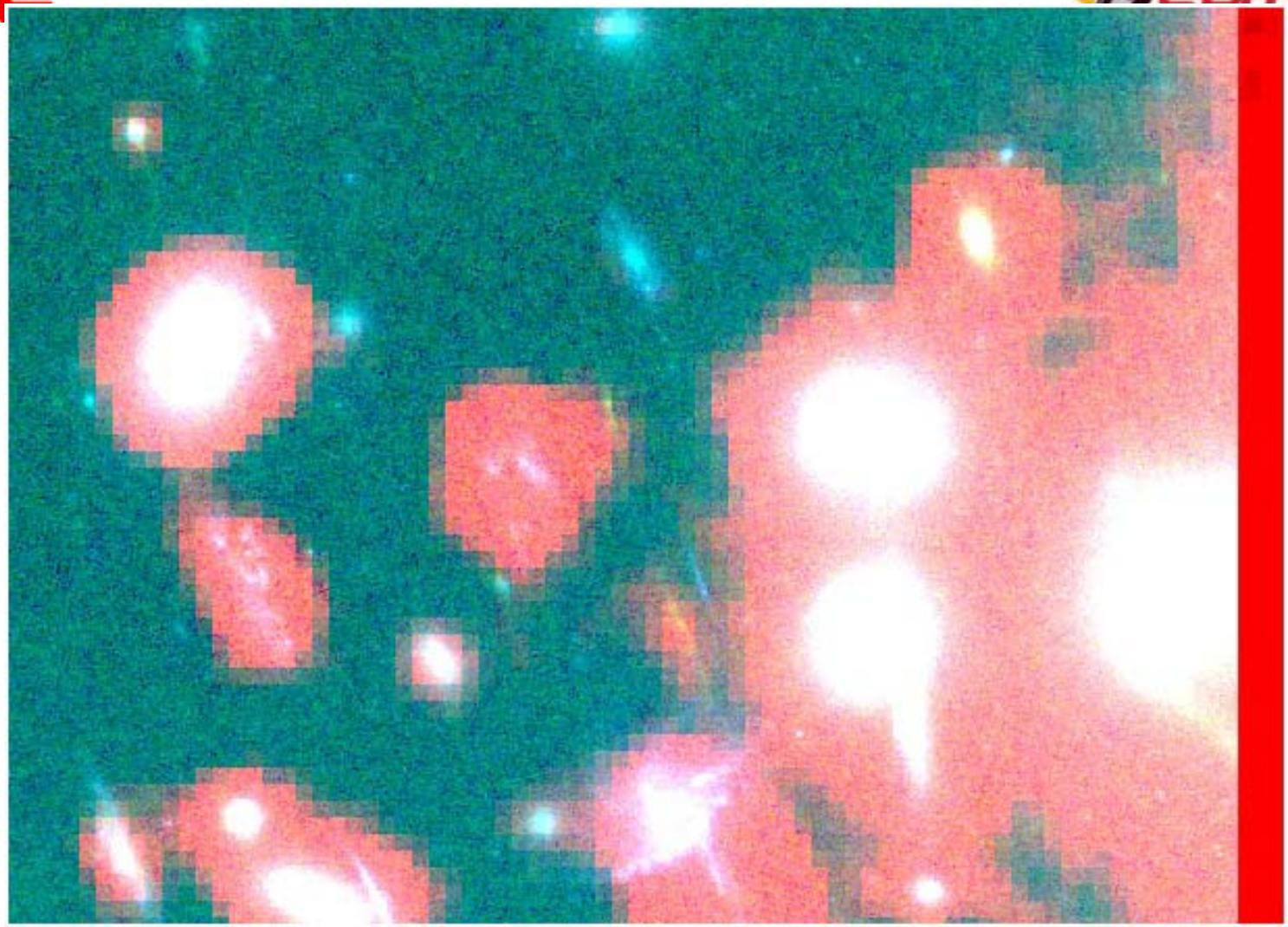
Dim and distant. The Hubble (*left*) and Spitzer (*right*) telescopes both see a magnified dwarf galaxy that arose about 600 million years after the big bang.

Spitzer, NASA's atellite's to faint

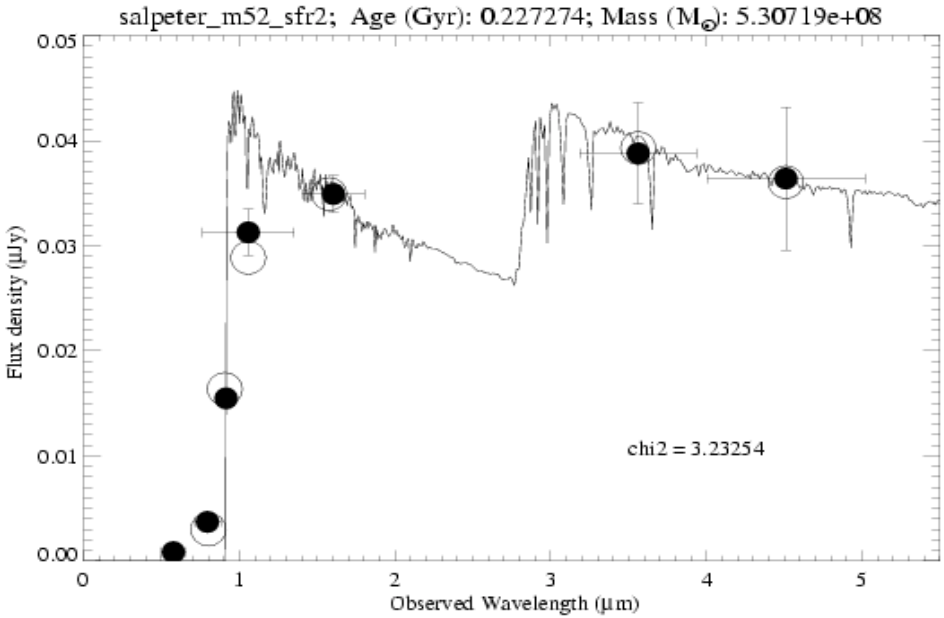
years. "The fact that Spitzer detects this object is a real triumph," says astronomer Richard Ellis of the California Institute of Technology (Caltech) in Pasadena

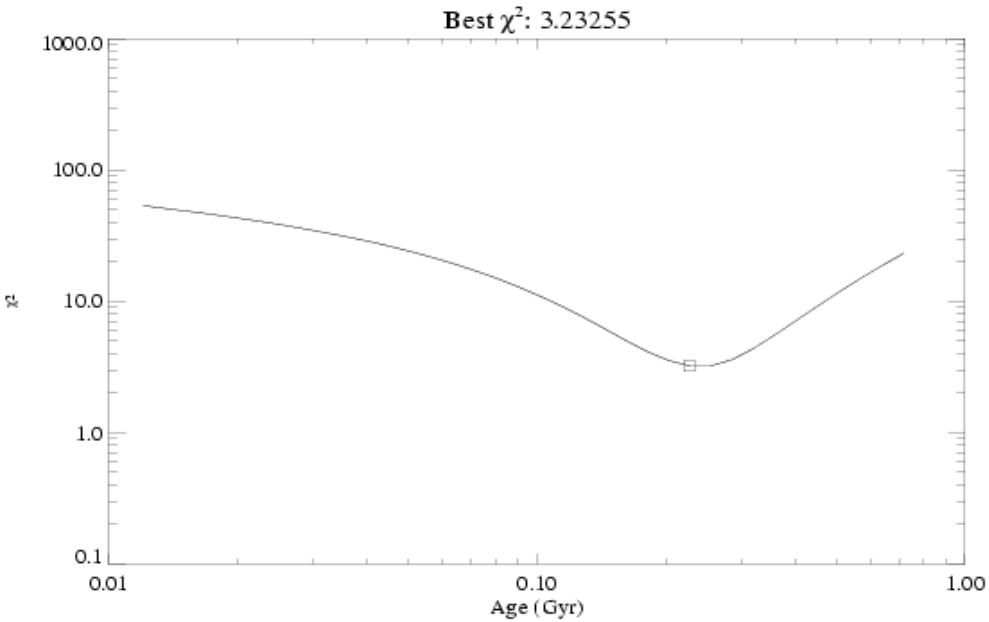
its stars had livec to detect the rest That's where sees the optical

Science, News of the Week, June 11, 2004



(HST optical (blue) & IRAC 4.5 μm)
E.Egami and the MIPS team + R.Ellis et al.





UV/optical SED flat in f_ν

One model fit

(Bruzual-Charlot 2003 model)

- Salpeter IMF (0.1-100 $M_\odot$)
- 0.4 $Z_\odot$ metallicity

↓

Age ~ 0.2 Gyr

Mass ~ 5 x 10^8 $M_\odot$

Preliminary results:

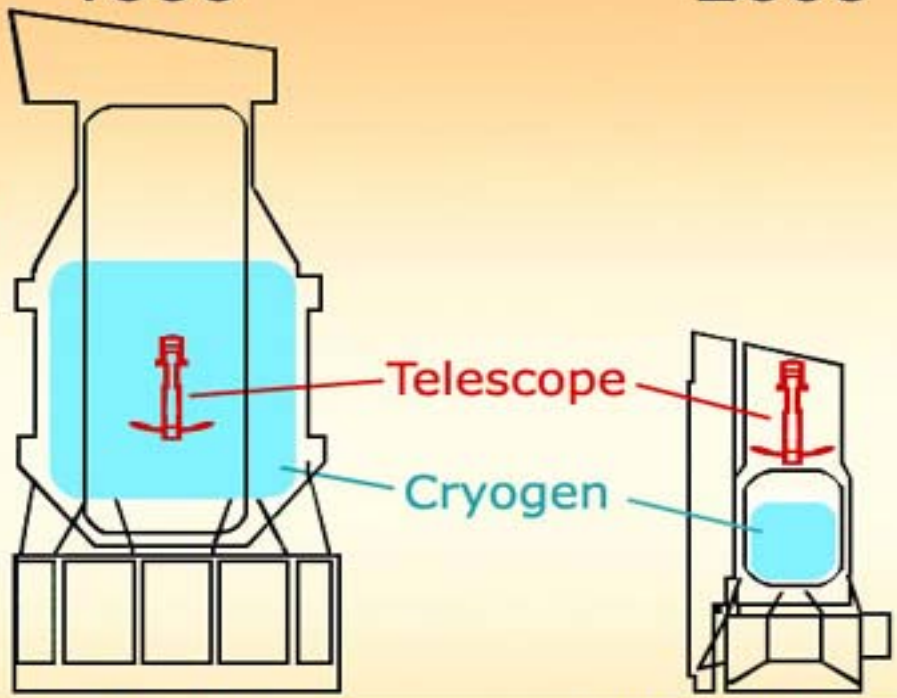
- Significant Balmer break
- Steeply rising continuum toward 1216 Å (low Z?)

Recent and Upcoming Science Milestones

- **Spitzer data archive opened, mid-May**
- **Results of first GO selection announced 28 May**
- **Denver AAS Meeting – 31 May – 3 June**
  - *Special Spitzer Session – all day on Tuesday 2 June*
  - *Numerous Spitzer related press releases, including joint Spitzer-Hubble release on GOODS results*
- **First Spitzer papers posted on SSC website and Astro-Ph starting June 1**
- **[You are here!]**
- **Special Spitzer issue of Astrophysical Journal Supplements, September 1**
- **First Spitzer Science conference, Pasadena, November 9-12.**
- **Cycle 2 Call for proposals – issued November 2004, due February, 2005**
  - ***We invite you to share the excitement of Spitzer!***

SPITZER SPACE TELESCOPE

DESIGN CHANGES



	COLD LAUNCH	WARM LAUNCH
Launch Mass	5700 kg	870 kg
Lifetime	5 years	5 years
Development Cost	~$2.2B	$0.67B
Launch Vehicle	Titan IV	Delta